

## CLAIMS

We claim:

1. A method for locating neighbor objects of a query geometry in a database, the method comprising:
  - 1) tiling a query geometry at a tiling level  $t$ ;
  - 2) conducting a search of a search area comprising interior and boundary tiles of the query geometry for neighbors, if the search does not produce a result set that includes a target number of neighbors, then the following steps are carried out starting with a radius  $r$  of 1:
    - 3) expanding the search area to a radius  $r$  tiles at a distance  $d$  from the boundary tiles and conducting a search for neighbors in the expanded search area, where  $(r-1)*tw < d \leq r*tw$ , wherein  $tw$  is the maximum or minimum of the x-width, y-width of a tile at level  $t$  and  $r$  is the query radius;
    - 4) using each tile in the expanded search area it is determined if there are any geometries at distance  $\leq r*tw$  that are to be included in the result set;
  - 5) if a target number of neighbors is not found, steps 3-4 are repeated with a query radius of 2 tile widths followed by 3 tile widths;
  - 6) if the target number still is not reached retiling the query geometry at a higher level of tiling; and
  - 7) repeating steps 1-7 until either the target number is reached or all objects in the database are searched.

1           2. The method according to claim 1, wherein geometries at distances  $>r*tw$  are included  
2 in the search with query radius  $r$ .

1           3. The method according to claim 1, wherein only a portion of tile in the expanded query  
2 radius are materialized prior to searching the expanded query radius for neighbors, and wherein  
3 additional tiles are materialized until all tiles at a specific query radius have been generated,  
4 searched and included in a result.

1           4. The method according to claim 3, wherein about 1000 to about 5000 tiles are  
materialized prior to searching.

1           6. The method according to claim 3, further comprising removing duplicate neighbors  
2 from the result.

1           7. The method according to claim 3, further comprising:  
2                 retaining only the target number of neighbors if more than the target number of  
3 neighbors is found and terminating the searching process.

1           8. A method for locating neighbor objects of a query object in a database, the method  
2 comprising:  
3                 defining a query tile set comprising a plurality of tiles that define an initial query radius  
4 that the query object is grouped within;  
5                 locating neighbor objects within the initial query radius;

Sub-A1

determining a number of neighbor objects within the initial query radius;  
expanding the query radius beyond the initial query radius by defining an expanded query  
tile set beyond the query tile set if the number of neighbor objects is less than a target number;  
locating neighbor objects within the expanded query radius;  
determining a number of neighbor objects within the expanded radius corresponds to a  
target number; and  
continuing to expand the query radius and locate neighbor objects within the expanded  
radius until the number of neighbor objects equals or exceeds the target number.

9. The method according to claim 8, further comprising:

calculating a distance of each neighbor object from the query object.

10. The method according to claim 9, wherein the distance of each neighbor object from  
the center of the query object is calculated.

11. The method according to claim 8, wherein the distance is based upon interboundary  
distance, boundary-to-boundary distance, or touch or intersect distance.

12. The method according to claim 8, further comprising:

redefining the initial query tile set as larger tiles to define a revised initial query radius if  
the target number of neighbor objects is not found in a minimum number of expansions of the  
query radius;

locating neighbor objects within the revised initial query radius;

Sub A1

6 determining a number of neighbor objects within the revised initial query radius;  
7 defining a revised expanded query radius beyond the revised initial query radius if the  
8 number of neighbor objects is less than the target number;  
9 locating neighbor objects within the revised expanded query radius;  
10 determining a number of neighbor objects within the revised expanded radius  
11 corresponds to the target number; and  
12 continuing to expand the query radius and locate neighbor objects within the expanded  
13 radius until the number of neighbor objects equals or exceeds the target number.

14 13. The method according to claim 12, wherein the minimum number of expansions is  
15 three.

16 14. The method according to claim 12, further comprising:  
17 determining whether an increased number of tiles exceeds a memory capacity of in which  
18 the database is stored prior to increasing the number of tiles; and  
19 if the increased number of tiles exceeds the memory capacity then redefining the tiles  
20 with an increased size.

21 15. The method according to claim 8, further comprising:  
22 calculating a distance of each located neighbor object from the query object if the number  
23 of neighbor objects in the initial query radius exceeds the target number to determine the target  
24 number of nearest neighbor objects.

Sub A1

16. The method according to claim 8, wherein the tiles are rectangular.

17. The method according to claim 8, wherein all of the tiles have the same shape and size.

18. The method according to claim 8, wherein the database comprises locations in a geographical region, the query object represents a first location in the geographical region, and the neighbor objects represent other locations in the geographical region.

19. The method according to claim 8, wherein the database is indexed with a linear quadtree.

20. The method according to claim 8, further comprising:  
assigning each tile a tile code and an associated geometry as the tiles are defined.

21. The method according to claim 8, wherein the query radius is expanded a selected distance and the method further comprises determining a number of tiles necessary to expand the query radius the selected distance.

22. The method according to claim 8, wherein the query radius is expanded a selected number of tiles.

23. The method according to claim 8, wherein the initial query radius and the expanded

Sub A1

2 query radius comprise the same number of tiles.

1 24. The method according to claim 8, wherein the query object is grouped within a  
2 plurality of tiles.

1 25. The method according to claim 24, wherein the query object is grouped completely  
2 or partially within the tiles.

1 26. The method according to claim 8, wherein the database comprises a spatial or  
2 geographic database.

2 27. The method according to claim 8, further comprising:  
organizing the neighbor objects in order of distance.

2 28. The method according to claim 8, further comprising:  
calculating a distance of each located neighbor object from the query to determine the  
3 target number of nearest neighbor objects.

1 29. The method according to claim 8, wherein the query object comprises a geometry  
2 that at least partially intersects at least one tile and the neighbor objects comprise geometries that  
3 at least partially intersect at least one tile.

1 30. The method according to claim 29, wherein at least one tile that the neighbor objects

SubA1  
2 intersect coincides with at least one tile that the query geometry intersects.

1 31. A computer program product for performing a process for locating neighbor objects of  
2 a query object in a database in a computer system, comprising:

3 a computer readable medium; and

4 computer program instructions, recorded on the computer readable medium, executable  
5 by a processor, for performing the steps of:

6 defining a query tile set comprising a plurality of tiles that define an initial query  
7 radius that the query object is grouped within;

8 locating neighbor objects within the initial query radius;

9 determining a number of neighbor objects within the initial query radius;

10 expanding the query radius beyond the initial query radius by defining an  
11 expanded query tile set beyond the query tile set if the number of neighbor objects is less  
12 than a target number;

13 locating neighbor objects within the expanded query radius;

14 determining a number of neighbor objects within the expanded radius corresponds  
15 to a target number; and

16 continuing to expand the query radius and locate neighbor objects within the  
17 expanded radius until the number of neighbor objects equals or exceeds the target  
18 number.

1 32. A system for performing a process for locating neighbor objects of a query object in a  
2 database, comprising:

Sub A1

a processor operable to execute computer program instructions; and  
a memory operable to store computer program instructions executable by the processor,  
for performing the steps of:  
defining a query tile set comprising a plurality of tiles that define an initial query  
radius that the query object is grouped within;  
locating neighbor objects within the initial query radius;  
determining a number of neighbor objects within the initial query radius;  
expanding the query radius beyond the initial query radius by defining an  
expanded query tile set beyond the query tile set if the number of neighbor objects is less  
than a target number;  
locating neighbor objects within the expanded query radius;  
determining a number of neighbor objects within the expanded radius corresponds  
to a target number; and  
continuing to expand the query radius and locate neighbor objects within the  
expanded radius until the number of neighbor objects equals or exceeds the target  
number.